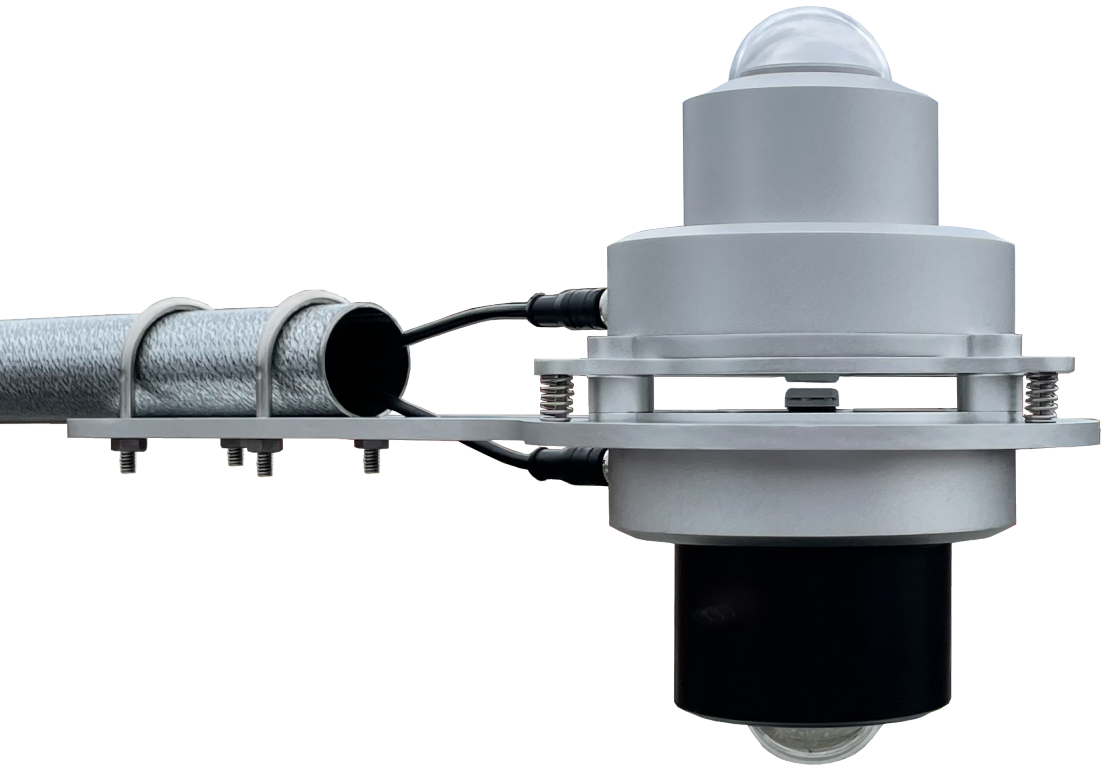
Spectrafy
solar spectral sensors

User Manual:

SolarSIM-ALB



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User information

Spectrafy strongly recommends reading this instruction manual prior to installation and operation of your Solar Spectral Albedometer (SolarSIM-ALB).

If you have any comments about this manual or our products, please send them to:

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Spectrafy reserves the right to make changes to the user manual without prior notice.

Warranty and liability

Spectrafy guarantees that the SolarSIM-ALB has been thoroughly tested to ensure that it meets all of the stated specifications. A two year warranty is provided from date of invoice, subject to correct installation and operation. Spectrafy accepts no liability for any loss or damages arising from improper usage of this product.

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Introduction

Dear customer, thank you for purchasing a Solar Spectral Albedometer (SolarSIM-ALB) from Spectrafy. The SolarSIM-ALB delivers a new standard in albedo measurement. Composed of two Class A SolarSIM-G spectral irradiance sensors back-to-back, the SolarSIM-ALB is the only albedometer capable of measuring both broadband and spectral albedo, simultaneously.

The SolarSIM-Gs, which make up the SolarSIM-ALB, use filtered photodiodes to make precise, multi-spectral measurements of the downwelling and reflected solar spectrum in several narrow wavelength bands. The SolarSIM-ALB's software then uses these measurements to accurately resolve the downwelling broadband and spectral solar irradiance, the reflected broadband and spectral irradiance and the resultant broadband and spectral albedos.

The SolarSIM-ALB is the first sensor that provides users with the ability to routinely characterize spectral albedo, information rich data that can provide important insights across a range of applications including PV resource assessment and plant monitoring, agricultural monitoring and ground-truthing of satellite data.

If you have any questions, please feel free to contact a Spectrafy representative or e-mail `info@spectrafy.com`

1 Main components

The SolarSIM-ALB components are shown in Figure 1, which includes

- a SolarSIM-G-1 (facing up),
- a SolarSIM-G-2 (facing down),
- a glare shield,
- a levelling plate,
- a levelling spring (x3),
- a mounting plate,
- mounting pipe U-bolts, and
- a mounting pipe.

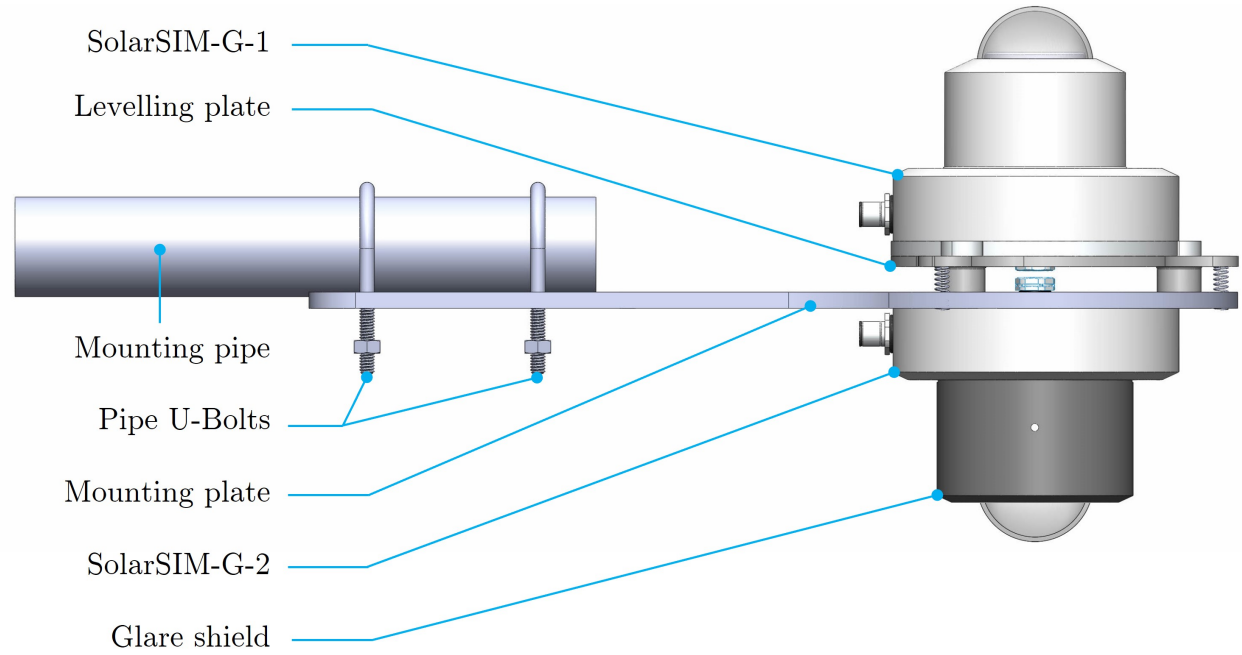

Figure 1: SolarSIM-ALB components.

1.1 SolarSIM-G-1

This SolarSIM-G is up-facing in order to measure the downwelling spectral irradiance.

1.2 SolarSIM-G-2

This SolarSIM-G is down-facing to measure the reflected or upwelling spectral irradiance. It has a glare shield.

1.3 Glare shield

The glare shield limits the field of view of the SolarSIM-G-2 to 170°.

1.4 Levelling plate

The levelling plate has two functions: 1) to mount the SolarSIM-Gs to face in opposite directions and 2) to level this assembly using three levelling springs and three mounting screws on the mounting plate.

1.5 Levelling springs & screws

The levelling springs together with levelling screws allow to level the SolarSIM-ALB using the three-point adjustment method.

1.6 Mounting plate

The mounting plate holds the assembled SolarSIM-ALB and allows attachment to the mounting pipe.

1.7 Mounting pipe & U-bolts

The U-bolts secure the assembled SolarSIM-ALB to the mounting pipe.

2 Installation

2.1 Contents of delivery

A typical SolarSIM-ALB package contains:

- 2 × SolarSIM-G,
- 2 × calibration certificates,
- 1 × glare shield,
- 1 × levelling plate,
- 3 × levelling springs and screws (M4×0.7, 25 mm long),
- 1 × mounting plate,
- 6 × mounting screws (M4×0.7, 12 mm long),
- 2 × pipe U-bolts,
- 1 × SolarSIM COMBOX,
- 1 × RS-485/power 2-to-1 splitter cable
- 1 × 10 m RS-485/power cable, double-ended
- 1 × 10 m RS-485/power cable, single-ended
- 1 × 3 ft USB cable
- 1 × USB drive loaded with the user manual and the software.

Please check the contents of the package and note if any damage has occurred during shipment. Please contact Spectrafy at `info@spectrafy.com` to facilitate the repair or replacement of any damaged components.

2.2 Mechanical installation

The SolarSIM-ALB installation starts by fastening the up-facing and down-facing SolarSIM-Gs to each side of the levelling plate, then securing this assembly on a mounting plate, which is then attached to a pipe. The aforementioned procedure is detailed as follows:

1. Fasten the up-facing SolarSIM-G (without the glare shield) to the levelling plate with the three 12 mm M4×0.7 flat head screws, as shown in Figure 2. Note the orientation of the levelling plate.

2. Fasten the down-facing SolarSIM-G to the other side of levelling plate with the three other 12 mm M4×0.7 flat head screws, as shown in Figure 3. Ensure SolarSIM-Gs' panel mount connectors are both pointing in the same direction.

3. Attach the SolarSIM-G assembly to a mounting plate via three springs and three 25 mm M4×0.7 screws, as demonstrated in Figure 4. Tighten the screws until they just protrude from the underside of the levelling plate.

4. Attach the two U-bolts to the mounting plate where U-bolt nuts are on the opposite side of the plate to the rectangular cut-out, as shown in Figure 5. Leave the nuts untightened sufficiently so that the U-bolts can easily slide over the mounting pipe (user provided). Note the mounting pipe diameter should be no larger than 1.75".

5. Mount the SolarSIM-ALB assembly to the mounting pipe so that the mounting plate sits under the pipe. Ensure the end of the pipe aligns with the end of the rectangular cut out on the mounting plate, as shown in Figure 5. Tighten the U-bolt nuts, while ensuring that the mounting plate is roughly level.

6. Connect the two female connectors of the SolarSIM splitter cable to the panel mount connector of each SolarSIM-G.

7. Connect the male connector of the splitter cable to either the single or the double-ended SolarSIM cable, depending on the chosen connectivity option (see Section 4 for more details).

8. Adjust the mounting screws on the levelling plate until the bubble level of the up-facing SolarSIM-G is centered.

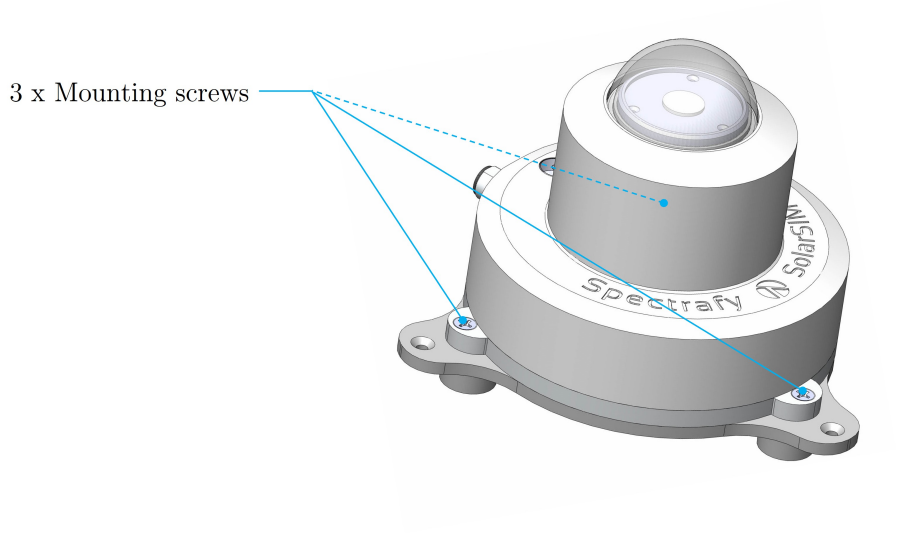

Figure 2: Up-facing SolarSIM-G assembled on the levelling plate. Note the orientation of the levelling plate.

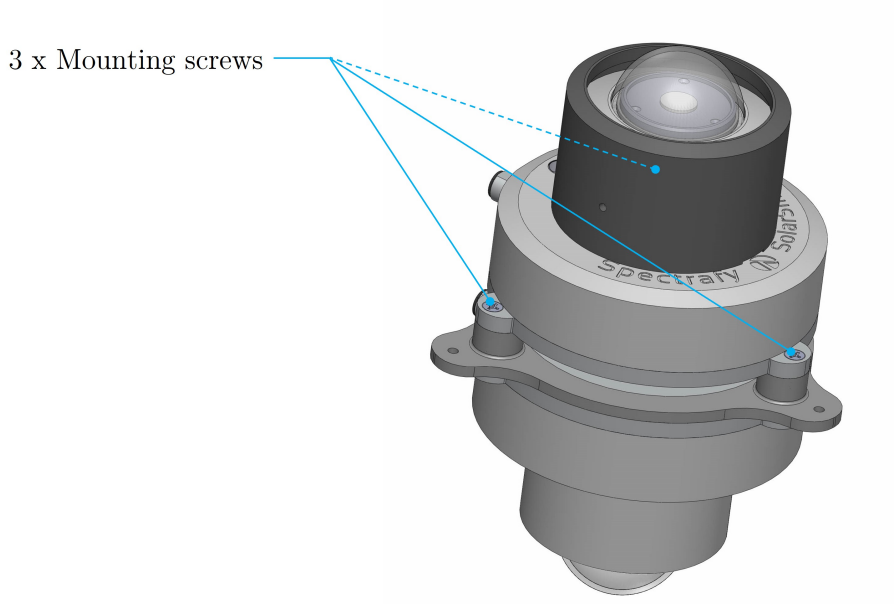

Figure 3: Both SolarSIM-Gs assembled on the levelling plate. Note the assembly is up side down for clearer illustration of the down-facing SolarSIM-G's mounting screws.

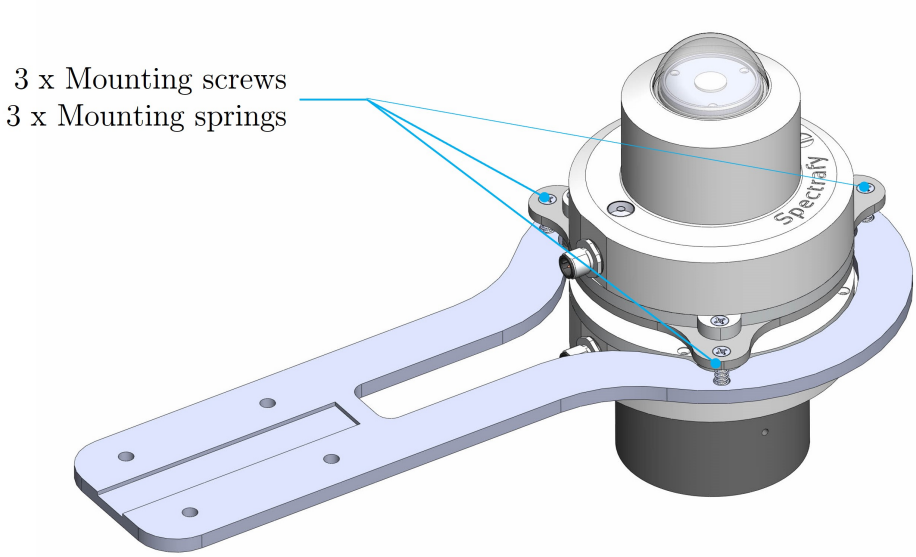

Figure 4: The SolarSIM-ALB fastened to a horizontal mounting pipe using two U-bolts. In addition to securing the SolarSIM-Gs to the mounting plate, the three springs and screws are also used to level the assembly.

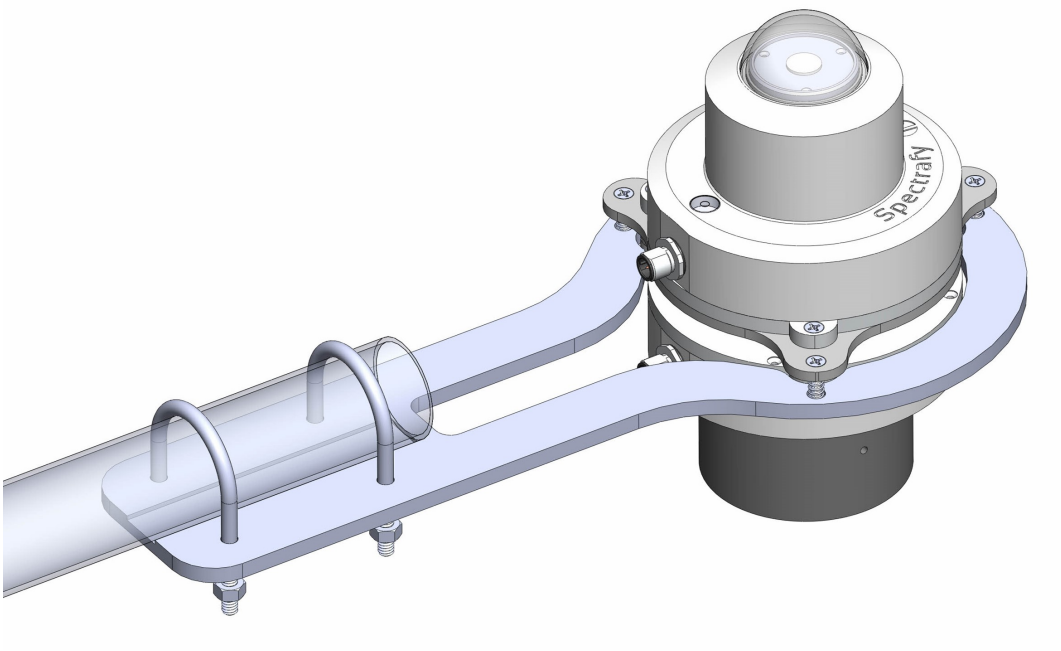

Figure 5: The SolarSIM-ALB fastened to a horizontal mounting pipe using two U-bolts. Note the location of bubble level on the up-facing SolarSIM-G.

3 Maintenance

3.1 Cleaning

The front glass of both SolarSIM-Gs should be periodically cleaned with a dry, non-abrasive cloth, to prevent the accumulation of dust and dirt.

3.2 Alignment

With each cleaning, it is also advised to make sure the SolarSIM-ALB is levelled using the bubble level of the up-facing SolarSIM-G.

3.3 Recalibration

We recommend that the SolarSIM-ALB is returned to Spectrafy for recalibration `every 1-2 years` in order to maintain ita specified measurement accuracy.

4 Connectivity

The SolarSIM-ALB offers various connectivity options suitable for most use case scenarios. The connectivity solutions include:

1. A SolarSIM COMBOX
2. A serial-over-Ethernet converter, or
3. A datalogger.

Option 1 uses the SolarSIM Communication Box (COMBOX) - a seamless link between a PC/laptop and the SolarSIM-ALB, as shown in Figure 6. A standard, 3 ft USB cable is connected from the COMBOX to a PC and a 10 m RS-485/power cable, with splitter, is connected from the COMBOX to the SolarSIM-ALB. This option is ideal for test sites and locations where one has access to a personal computer (PC) or when quick, in-field spectral albedo measurements are necessary with a laptop. Nte that, if needed, Spectrafy can provide power cables much longer than our standard 10m cable to enable the use of a COMBOX.

Option 2 allows the user to interface with the SolarSIM-ALB via a serial-over-Ethernet converter, provided there is internet access. For this option, the user must manually follow the wiring guide provided in Section 4.2. This option is ideal for test sites and locations which have internet access, but no PC nearby. Both options 1 and 2 make use of the SolarSIM-ALB DAQ graphical user interface, which must be installed on a Windows-based PC or a server, as explained in Section 5.

Option 3 uses a datalogger to acquire raw data from the SolarSIM-ALB. This raw data must be specifically formatted by the user into a .csv file, which is then fed into the Albedometer SolarSG software to generate the complete SolarSIM-ALB data set, as detailed in Section 6.4. This option is ideal for remote test sites and locations with existing datalogger-based data acquisition systems.

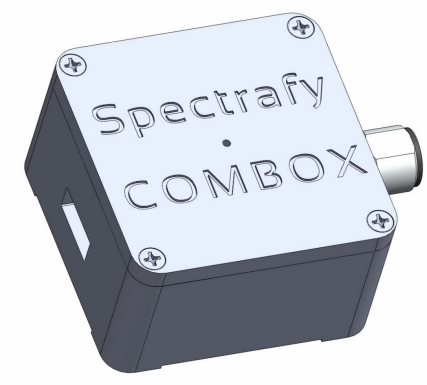

Figure 6: The COMBOX is used to interface the SolarSIM-ALB to a PC.

4.1 COMBOX

The COMBOX is the easiest option to start acquiring data from the SolarSIM-ALB. Please follow these steps to use the COMBOX:

1. Install the SolarSIM-ALB DAQ application as described in Section 5.
2. Connect one end of the double-ended RS-485/power cable to the male connector of the SolarSIM-ALB's splitter cable.
3. Connect the other end of the double-ended RS485/power cable to the COMBOX.
4. Connect one end of the USB cable to the COMBOX's USB port.
5. Connect the other end of the USB cable to a PC. A blue LED on the top of the COMBOX should light up.

4.2 Serial-over-Ethernet converter

For remote test site applications the SolarSIM-ALB can be connected to a networked PC via a suitable serial-over-Ethernet (SOE) converter - such as the ICP DAS I-7188-E2[1]. The user must connect the SolarSIM-ALB RS-485/power cable wires as per Table 1. More specifically, the D+ and D− lines, brown and black wires, respectively, must be connected to the corresponding terminal block inputs on the SOE device, while the blue and white wires - to the positive and common ground sides of the 12 VDC power supply, respectively. The SOE converter and the power supply must share a common ground.

The network must assign a static IP address to the SOE converter. Afterwards, a virtual communication link can be established via the VxComm software[2]. The latter must be configured as per Figures 7 and 8. Once properly configured, the VxComm software creates a virtual serial port on the networked PC, which the SolarSIM-ALB DAQ application uses to communicate to the SolarSIM-ALB.

[1] `https://www.icpdas-usa.com/i_7188e2.html`
[2] `http://ftp.icpdas.com/pub/cd/8000cd/napdos/driver/vxcomm_driver/windows/`

Table 1: Wiring guide for the SolarSIM-G.

Colour	Label	Function
Blue	V_{in}	Input voltage (+12 VDC)
White	GND	Common ground
Black	D−	Negative RS-485 input
Brown	D+	Positive RS-485 input

*12 VDC only

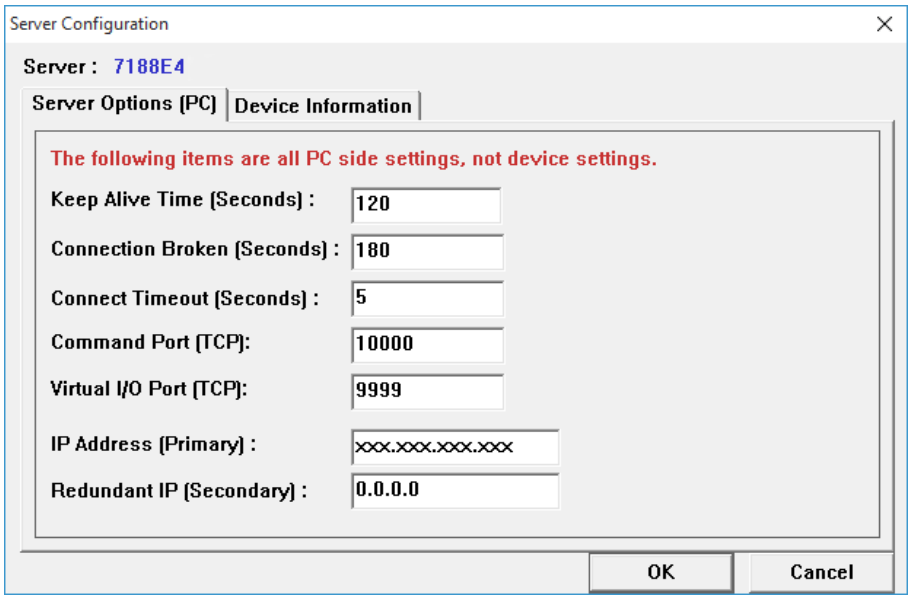

Figure 7: Server configuration for VxComm software. Note, the SolarSIM-ALB supports only the ASCII RS-485 communication mode.

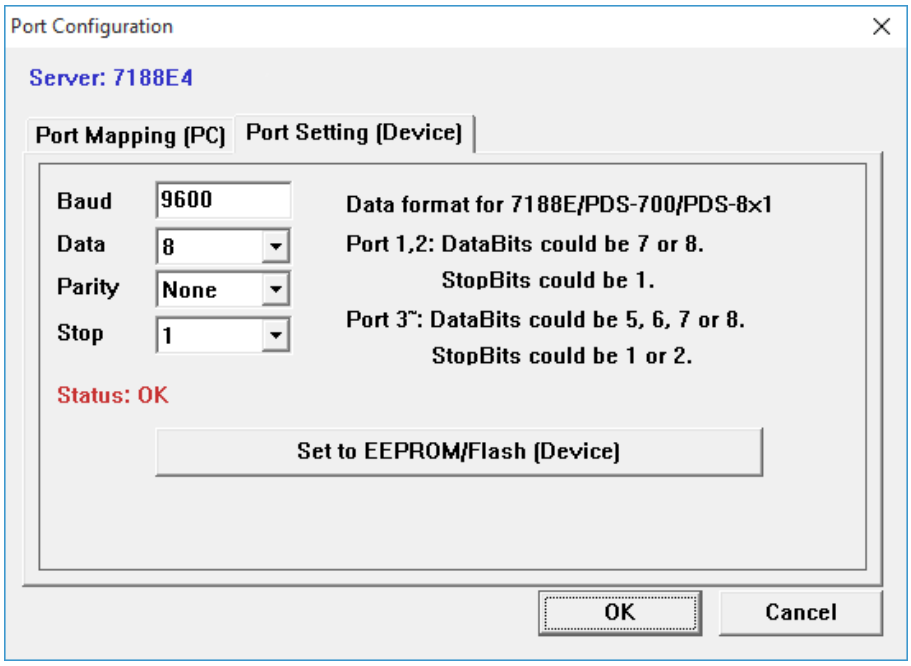

Figure 8: Port configuration for VxComm software. Note, the SolarSIM-ALB supports only the ASCII RS-485 communication mode.

4.3 Datalogger

Connectivity with a datalogger is similar to the SolarSIM-ALB's integration with the SOE converter. The SolarSIM-ALB's RS-485/power cable is connected to the corresponding datalogger inputs as per Section 4.2. Note the datalogger must have an available RS-485 port.

5 SolarSIM-ALB DAQ Application

The SolarSIM-ALB DAQ application provides the user with the real-time instrument status, data acquisition, data storage, and daily/real-time data plots. The application communicates via a serial port and thus can be used with either a COMBOX or a SOE converter. This section will cover the software installation, the program settings, and the general know-how for using the SolarSIM-ALB DAQ.

5.1 Software installation

The software installation is performed by running the setup.exe executable located in the `SolarSIM setup` folder on the provided USB key, as shown in Figure 9. The user should follow the installation instructions as prompted by the installer.

5.2 Software settings

Once the SolarSIM-ALB DAQ software is installed, the user must define the location-specific settings. This process can be accomplished in two ways. The first option is for the user to

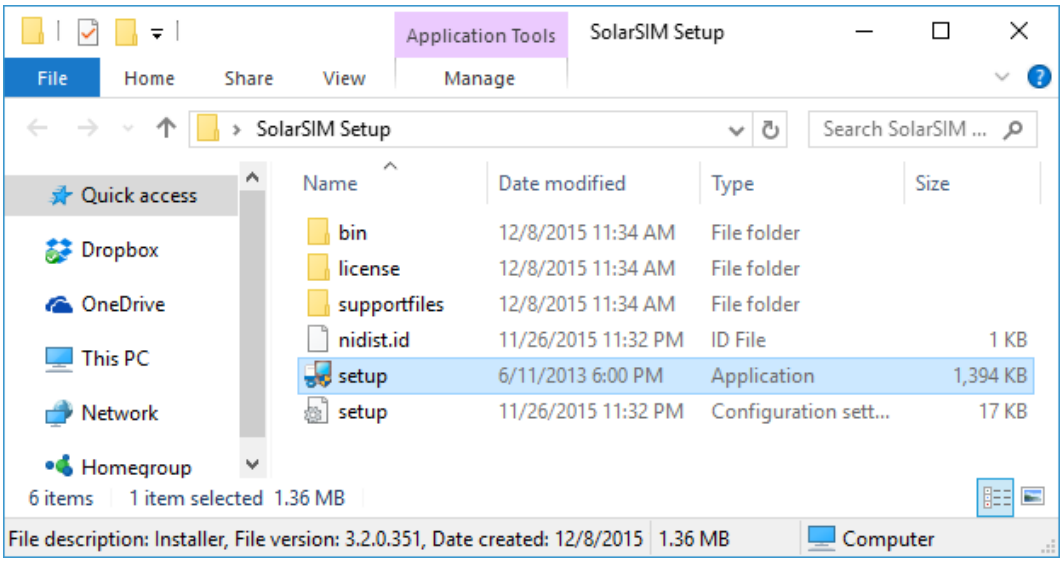

Figure 9: Installation of the SolarSIM-ALB DAQ software

change the values for altitude, longitude, and latitude in the user_settings.conf file, located in the Settings folder of the installation directory, as shown in Figure 10. The second option is to modify these parameters when automatically prompted by the software, as will be explained in Section 5.3. Modifications to the remaining parameters are optional.

Auto mode
If Auto mode is turned ON , then upon launching, the application does not seek user input and begins data collection automatically. To turn Auto mode on select < 1 > in the Auto mode field.

DAQ rate and Sampling rate
The DAQ rate sets the data acquisition rate for the entire SolarSIM-ALB data set, while Sampling rate is the sampling frequency for acquiring raw albedometer data, i.e. the SolarSIM-ALB DAQ retrieves raw data from instruments at the Sampling rate, then averages, processes, and saves this data at the DAQ rate.

Custom spectrum timer and Spectrum timer
If it is desired to have a separate data acquisition rate for the spectral data, the user can input < 1 > next to the Custom spectrum timer and change the spectral data acquisition to a desired rate via the Spectrum timer.

Raw data output
If the user wishes to save the raw data from the SolarSIM-ALB, input < 1 > next to the Raw data output.

Please refer to Table 2 for a summary of the user settings as well as default values for all parameters.

Table 2: SolarSIM-ALB DAQ program settings.

Setting	Range	Default	Units
Altitude	0.0 to 9000	70.0	metres
Longitude	-180° to 180°*	-75.677	degrees
Latitude	-90° to 90°**	45.459	degrees
Auto mode	0 or 1	0 (OFF)	OFF or ON
DAQ rate	2 to 3600	10	seconds
Sampling rate	2 to 3600	2	seconds
Custom spectrum timer	0 or 1	1 (ON)	OFF or ON
Spectrum timer	2 to 3600	30	seconds
Raw data output	0 or 1	1 (ON)	OFF or ON

*longitude is negative for western hemisphere
**latitude is negative for southern hemisphere

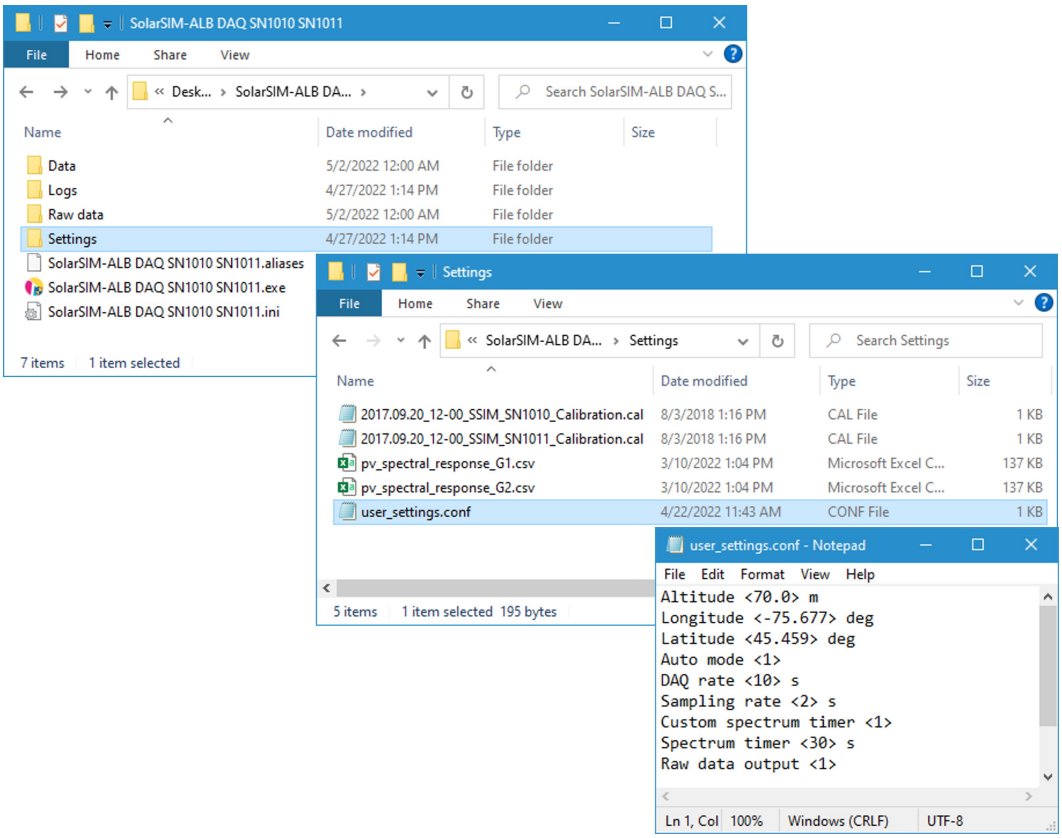

Figure 10: Modifying SolarSIM-ALB user settings.

5.3 Using the software

The SolarSIM-ALB DAQ software is launched by double-clicking the SolarSIM-ALB DAQ.exe in the installation directory. The application runs, by default, in the administrator mode, as it this is required in order to save data in the Program files directory.

The SolarSIM-ALB DAQ software searches for the serial port(s) to which the up-facing and down-facing SolarSIM-Gs are connected. If one of the SolarSIM-Gs is not detected, the program displays the message as shown in Figure 11 and exits. In this case, please ensure that your PC detects the serial port by viewing the available serial or COM ports in the Device manager. If similar problem arises with the SOE converter, please double-check the setup procedure as explained in Section 4.2.

Once the SolarSIM-ALB is found, the SolarSIM-ALB DAQ prompts the user to verify and/or change the geographic settings, which include altitude, longitude and latitude, as shown in Figure 12. If these parameters are incorrect, the user can change them in real-time by modifying the appropriate values in the pop-up window. When ready, press Apply, and the program will save these settings by writing them to the user_settings.conf file. Please note that the latitude must be negative for southern and western hemispheres, respectively.

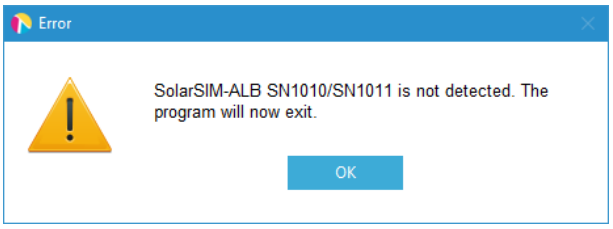

Figure 11: Failing to detect the SolarSIM-ALB.

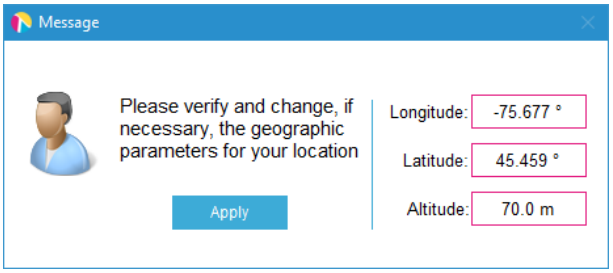

Figure 12: Changing and verifying geographic settings.

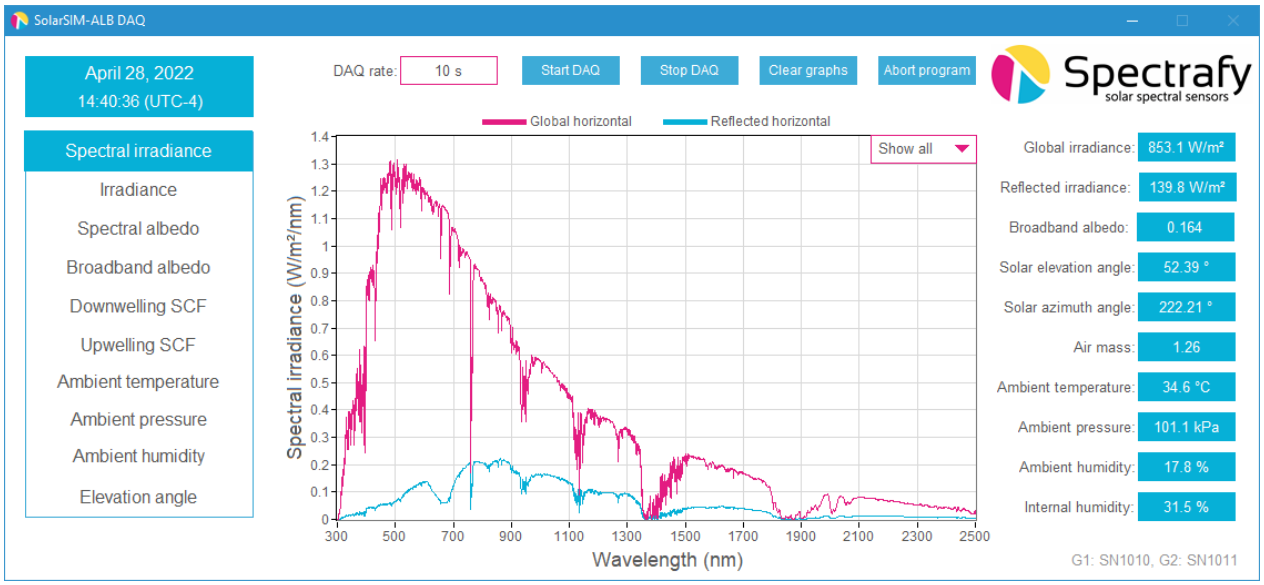

Figure 13: SolarSIM-ALB DAQ application

After the geographic settings are verified, the application starts to automatically acquire data at the DAQ rate, which is displayed to the left of the Start DAQ button, shown in Figure 13. The software displays, in real-time, spectral global horizontal and reflected horizontal irradiances and spectral albedo in either the 300–1200 nm or 300–2500 nm range[3],

[3]the displayed spectral range is limited for better visualization. The resultant spectral data is saved in either the 280–1200 nm or the 280–4000 nm range

depending on the purchased option. The daily profiles of the broadband global horizontal and reflected irradiances, and the broadband albedo are also recorded. Additionally, the user can visualize daily plots of ambient temperature, ambient pressure and ambient humidity. For users who have purchased Spectral Correction Factor (SCF) package, the daily plots of downwelling (up-facing) and up-welling (down-facing) SCFs are also available.

5.4 Data type and storage

The SolarSIM-ALB DAQ stores the processed data in the Data folder, located in the installation directory. The application outputs two data types: the solar spectral files and the daily summary data files.

Solar spectral files
The spectral irradiance data is stored in the Data\Spectra\yyyymmdd directory, where yyyy, mm, and dd correspond to the year, month, and day, respectively. A snippet of the SolarSIM-ALB spectral file is presented in Figure 14. As shown, the file includes global and reflected spectral irradiances, and spectral albedo - all as a function of wavelength. Note the wavelength column is not included in order to minimize the file size. The values in row 2 correspond to 280 nm, while the values in row 3722 correspond to 4000 nm.

Daily summary data files
The daily summary data files are stored in the Data folder. A snippet of the SolarSIM-ALB data file is shown in Figure 15. It contains the values for the elevation and azimuth angles, the ambient measurements from both SolarSIM-G1 (up-facing) and the SolarSIM-G2 (down-facing), the broadband global and reflected irradiances, as well as the broadband albedo. For users who have purchased the SCF or UV package, the daily summary files would include additional, corresponding outputs.

5.5 Data collection size

At 10 s DAQ resolution the daily summary file's size is ∼2MB. The spectral file size is ∼105 KB per measurement. The size of the entire spectral file data set depends on the amount of sunlight hours. To reduce the amount of stored spectral data, the user is encouraged to modify the Spectrum timer parameter in the user_settings.conf file to suit your data storage needs.

	A	B	C
1	Global spectral irradiance (280-4000nm) (W/m2/nm)	Reflected spectral irradiance (W/m2/nm)	Spectral albedo
2	0.003701	0.002125	0.574295
3	0.007941	0.00458	0.576796
4	0.013107	0.007592	0.579227
5	0.014933	0.008686	0.58165
6	0.013495	0.007882	0.584072
7	0.004796	0.002813	0.586495
8	0.011713	0.006915	0.590399
9	0.013998	0.008321	0.594468
10	0.008935	0.005348	0.598536

Figure 14: SolarSIM-ALB spectral data file.

A	B	C	D	E	F	G	H	I
Timestamp	Timezone (hr)	Elevation (deg)	Azimuth (deg)	G1: Ambient temperature (C)	G1: Ambient pressure (kPa)	G1: Ambient humidity (%)	G1: Internal temperature (C)	G1: Internal humidity (%)
2022-05-01- 13:00:00	-4	59.769	180.098	34.72	100.92	16.9	35.31	30.5
2022-05-01- 13:00:10	-4	59.769	180.178	34.73	100.92	17	35.33	30.5
2022-05-01- 13:00:20	-4	59.769	180.257	34.74	100.92	16.9	35.33	30.4
2022-05-01- 13:00:30	-4	59.769	180.337	34.74	100.92	16.9	35.33	30.5
2022-05-01- 13:00:40	-4	59.769	180.417	34.75	100.92	16.9	35.35	30.4
2022-05-01- 13:00:50	-4	59.769	180.497	34.76	100.92	16.9	35.34	30.4
2022-05-01- 13:01:00	-4	59.768	180.577	34.77	100.92	16.9	35.38	30.5
2022-05-01- 13:01:10	-4	59.768	180.657	34.77	100.92	16.9	35.37	30.5
2022-05-01- 13:01:20	-4	59.768	180.736	34.78	100.92	16.9	35.38	30.5
2022-05-01- 13:01:30	-4	59.767	180.816	34.79	100.92	16.9	35.39	30.5

J	K	L	M	N	O	P	Q
G2: Ambient temperature (C)	G2: Ambient pressure (kPa)	G2: Ambient humidity (%)	G2: Internal temperature (C)	G2: Internal humidity (%)	Global irradiance (W/m2)	Reflected irradiance (W/m2)	Broadband albedo
34.47	100.95	15.8	35.19	32.5	449.91	410.97	0.913
34.48	100.95	15.8	35.18	32.5	449.58	410.72	0.914
34.48	100.95	15.8	35.18	32.6	447.41	408.74	0.914
34.48	100.95	15.8	35.19	32.5	445.25	407.8	0.916
34.49	100.95	15.8	35.2	32.5	446.34	408.57	0.915
34.49	100.95	15.8	35.2	32.4	445.04	406.66	0.914
34.5	100.95	15.8	35.22	32.5	439.14	401.4	0.914
34.5	100.95	15.8	35.21	32.5	437.96	401	0.916
34.51	100.95	15.8	35.21	32.5	439.71	401.83	0.914
34.51	100.95	15.8	35.25	32.5	437.8	400.71	0.915

Figure 15: SolarSIM-ALB daily summary file.

5.6 Changing default language for non-Unicode characters

For users of computers with non-Latin based languages, such as Chinese, the SolarSIM-ALB DAQ may improperly display non-Unicode characters. To solve this problem, the user must change the default language for non-Unicode programs to English. To do so, first locate the Clock, Language, and Region settings in the Control Panel, then click on Region settings, as show in Figure 16. Then navigate to the Administrative tab and select Change system locale..., as demonstrated in Figure 17. Lastly, change the language to English from the drop down menu, as shown in Figure 18, and press OK.

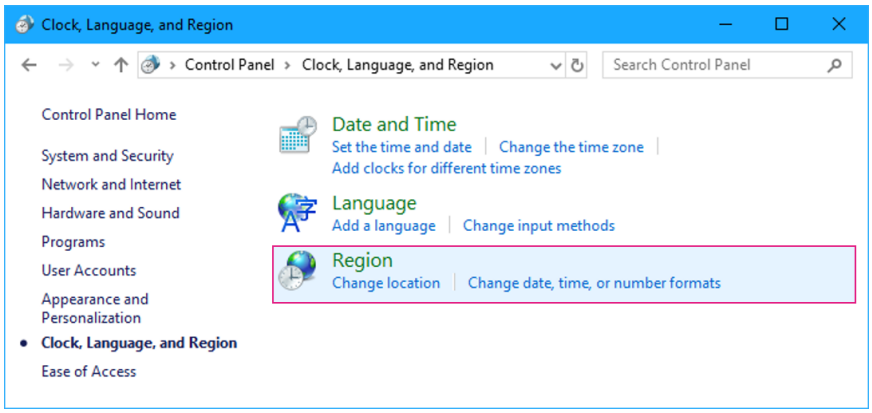

Figure 16: Clock, Language, and Region settings in the Control Panel.

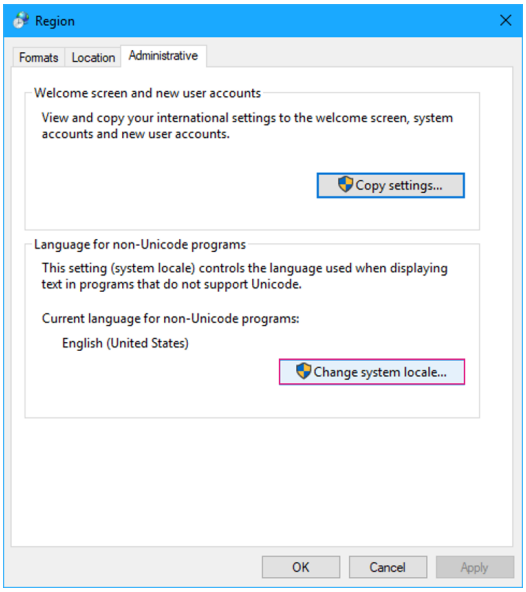

Figure 17: Changing the system locale in the Administrative tab of the Region settings.

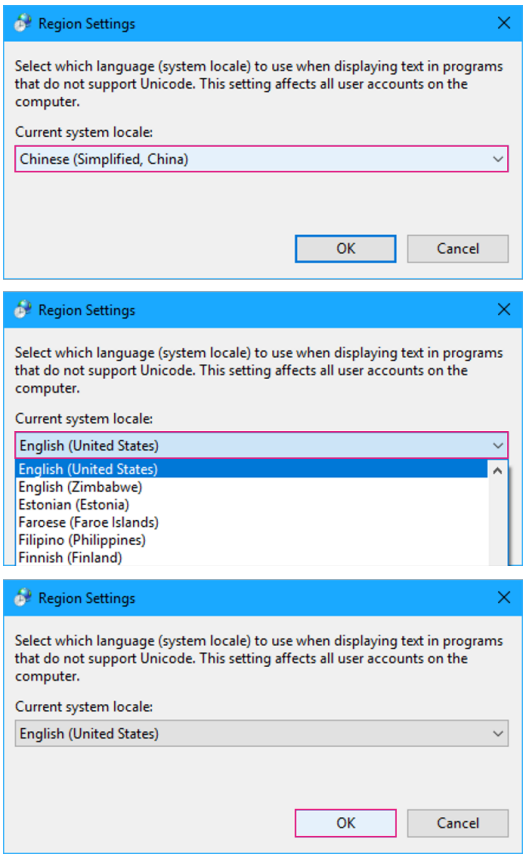

Figure 18: Changing the default language for non-Unicode characters..

6 Datalogger setup

The SolarSIM-ALB can be interfaced with most RS-485 equipped dataloggers. The basic steps to retrieve and process the raw data from the SolarSIM-ALB are as follows:

1. Retrieve raw data from the SolarSIM-ALB using a datalogger.
2. Format raw data from the datalogger into daily files with a specific format.
3. Process daily raw data files using Spectrafy's SolarSG-ALB application.

This section discusses in detail how to proceed with each step, including the serial port configuration, sending and parsing the serial commands, formatting the SolarSIM-ALB raw data into a required format, and how to use the SolarSG-ALB software.

6.1 Serial port configuration

Prior to configuring the serial port on a datalogger, the user must wire the SolarSIM-ALB by following instructions from Section 4.2. The serial port is then configured with standard serial parameters as per Table 3.

6.2 Serial commands

Since the SolarSIM-ALB is the assembly of two SolarSIM-Gs, the datalogger must send to acquire the raw data from both instruments. To retrieve raw data from each SolarSIM-G, the datalogger must send the following command:

`Nxxxx_E`

where `xxxx` corresponds to the 4-digit serial number of the SolarSIM-G. In response, the SolarSIM-G sends an ASCII string with the ambient temperature, ambient pressure, ambient humidity, internal temperature, internal humidity, and the nine voltages from the SolarSIM-G's measurement channels. The following ASCII string is a sample output:

```
N1010_2500.000,1013.120,4750.000,2600.000,1050.000,2500.032,4999.999,
0000.001,1274.004,2746.321,3291.214, 3924.385,1900.500,0500.123/r/n
```

Table 3: SolarSIM-G serial port configuration.

Parameter	Value
Baud rate	9600
Parity	None
Data bits	8
Stop bits	1

The aforementioned string can be parsed as:

N"serial number"_"$(T_{\text{out}} + 50) \times 75$","$P_{\text{out}} \times 10$","$H_{\text{out}} \times 100$","$(T_{\text{in}} + 50) \times 75$","$H_{\text{in}} \times 100$",
"V_1","V_2","V_3","V_4","V_5","V_6","V_7","V_8","V_9","end of line character"

where T_{out}, P_{out}, H_{out}, T_{in}, H_{in}, and V_{1-9} are the ambient temperature, the ambient pressure, the ambient humidity, the internal temperature, the internal humidity, and the nine voltages from the detectors, respectively. The aforementioned example string is parsed in Table 4.

Table 4: Processed output example for `Nxxxx_E` command.

Parameter	Symbol	Value	Units
Ambient temperature	T_{out}	-16.67	°C
Ambient pressure	P_{out}	101.312	kPa
Ambient humidity	H_{out}	47.50	%
Internal temperature	T_{in}	-15.33	°C
Internal humidity	H_{in}	10.50	%
Voltage channel 1	V_1	2500.032	mV
Voltage channel 2	V_2	4999.999	mV
Voltage channel 3	V_3	0.001	mV
Voltage channel 4	V_4	1274.004	mV
Voltage channel 5	V_5	2746.321	mV
Voltage channel 6	V_6	3291.214	mV
Voltage channel 7	V_7	3924.385	mV
Voltage channel 8	V_8	1900.500	mV
Voltage channel 9	V_9	500.123	mV

6.3 Datalogger programming

For datalogger programming details please see Spectrafy's application note on integration of the SolarSIM-ALB with a CR6 datalogger from Campbell Scientific.

6.4 Raw data file format

The SolarSG-ALB software requires as an input the .csv raw data file in a specific format. The file must have the following headings in strict order with the corresponding data:

Timestamp
Timezone (hr)
G1: Ambient temperature (C)
G1: Ambient pressure (kPa)
G1: Ambient humidity (%)
G1: Internal temperature (C)
G1: Internal humidity (%)
G1: V1 (mV)
G1: V2 (mV)
G1: V3 (mV)
G1: V4 (mV)
G1: V5 (mV)
G1: V6 (mV)
G1: V7 (mV)
G1: V8 (mV)
G1: V9 (mV)
G2: Ambient temperature (C)
G2: Ambient pressure (kPa)
G2: Ambient humidity (%)
G2: Internal temperature (C)
G2: Internal humidity (%)
G2: V1 (mV)
G2: V2 (mV)
G2: V3 (mV)
G2: V4 (mV)
G2: V5 (mV)
G2: V6 (mV)
G2: V7 (mV)
G2: V8 (mV)
G2: V9 (mV)

Each data row must consists of comma separated values only, with no spaces in between. The timestamp must be strictly in the format yyyy-mm-dd HH:MM:SS, where yyyy, mm, dd, HH, MM, and SS is the year, month, day, hour, minute, and second, respectively. The SolarSG-ALB software uses the timestamp and the timezone from the raw data file to determine the UTC time, which is necessary to run the software's solar position algorithm. Therefore, the user must ensure that each timestamp plus the timezone corresponds to the

UTC time. The snippet of the raw data file is presented in Figure 19. The raw data file must be named as `yyyy-mm-dd_SSIM_Raw_Data_SNxxxx_SNzzzz.csv`, where `yyyy`, `mm`, `dd` correspond to the year, month, and day when the raw SolarSIM-ALB data was generated, while `xxxx` is the 4-digit serial number of the up-facing SolarSIM-G or G1, and `zzzz` is the serial number of the down-facing SolarSIM-G or G2.

6.5 SolarSG-ALB application

The SolarSG-ALB application is an executable that is used to process the raw data from the SolarSIM-ALB into the processed spectral and broadban data. This software is located on the provided USB key inside a SolarSG-ALB folder with contents as per Figure 20, which initially include:

- albParam.data
- atmParam.data
- SolarSG-ALB.exe
- SSIM_Calibration_SNxxxx.json
- SSIM_Calibration_SNzzzz.json
- user_settings.conf

Pleas note, the calibration files for the SolarSG-ALB application is in a .json format, in contrast to the .cal file format used by the SolarSIM-ALB DAQ application. Prior to running the SolarSG-ALB application the user must configure[4] the local geographic settings in the

[4]any text editor, e.g. Notepad, can be used to modify the settings

A	B	C	D	E	F	G
Timestamp	Timezone (hr)	G1:Ambient temperature (C)	G1:Ambient pressure (kPa)	G1:Ambient humidity (%)	G1:Internal temperature (C)	G1:Internal humidity (%)
2022-05-01 00:00:00	-4	23.77	101.1	25.5	24.59	31.7
2022-05-01 00:00:10	-4	23.77	101.1	25.5	24.58	31.9
2022-05-01 00:00:20	-4	23.77	101.1	25.5	24.58	31.8

H	I	J	K	L	M	N	O	P
G1:CH1 (mV)	G1:CH2 (mV)	G1:CH3 (mV)	G1:CH4 (mV)	G1:CH5 (mV)	G1:CH6 (mV)	G1:CH7 (mV)	G1:CH8 (mV)	G1:CH9 (mV)
0.209	0.283	0.21	0.361	0.23	0.188	0.263	1.14	0.358
0.207	0.289	0.217	0.359	0.232	0.193	0.266	0.993	0.351
0.206	0.293	0.215	0.356	0.23	0.191	0.263	0.853	0.418

Q	R	S	T	U
G2:Ambient temperature (C)	G2:Ambient pressure (kPa)	G2:Ambient humidity (%)	G2:Internal temperature (C)	G2:Internal humidity (%)
23.52	101.15	24.7	24.37	33.7
23.52	101.15	24.7	24.37	33.7
23.52	101.15	24.7	24.37	33.7

V	W	X	Y	Z	AA	AB	AC	AD
G2:CH1 (mV)	G2:CH2 (mV)	G2:CH3 (mV)	G2:CH4 (mV)	G2:CH5 (mV)	G2:CH6 (mV)	G2:CH7 (mV)	G2:CH8 (mV)	G2:CH9 (mV)
0.187	0.253	0.192	0.262	0.202	0.169	0.237	0.591	1.274
0.185	0.252	0.193	0.249	0.204	0.172	0.245	0.532	1.387
0.183	0.248	0.19	0.253	0.212	0.176	0.242	0.791	1.328

Figure 19: SolarSG-ALB raw data file.

user_settings.conf file, by modifying the altitude, longitude, and latitude, corresponding to the location of your SolarSIM-G, as shown in Figure 20. Please refer to Table 2 for the allowed ranges and the positive/negative convention of these parameters. Furthermore, the user must set the proper order for the up-facing and down-facing SolarSIM-Gs via SolarSIM-G1 SN and SolarSIM-G2 SN parameters, respectively. For example, from Figure 20, the up-facing SolarSIM-G has the serial number SN1010, while the down-facing SolarSIM-G has the serial number 1011. Finally, place the raw data .csv file(s) formatted as per Section 6.4 in the SolarSG-ALB directory and launch the application to process the data.

Once launched, the SolarSG-ALB application scans the directory for new raw data files. If raw data files are found, the software processes each file line-by-line. The SolarSG-ALB application creates two data folders inside the ...Processed Data\\Global directory. The daily summary files and spectra folders contain data identical to date generated by SolarSIM-ALB DAQ, as discussed in Section 5.4. Finally, the processed raw data files are moved to the archive folder.

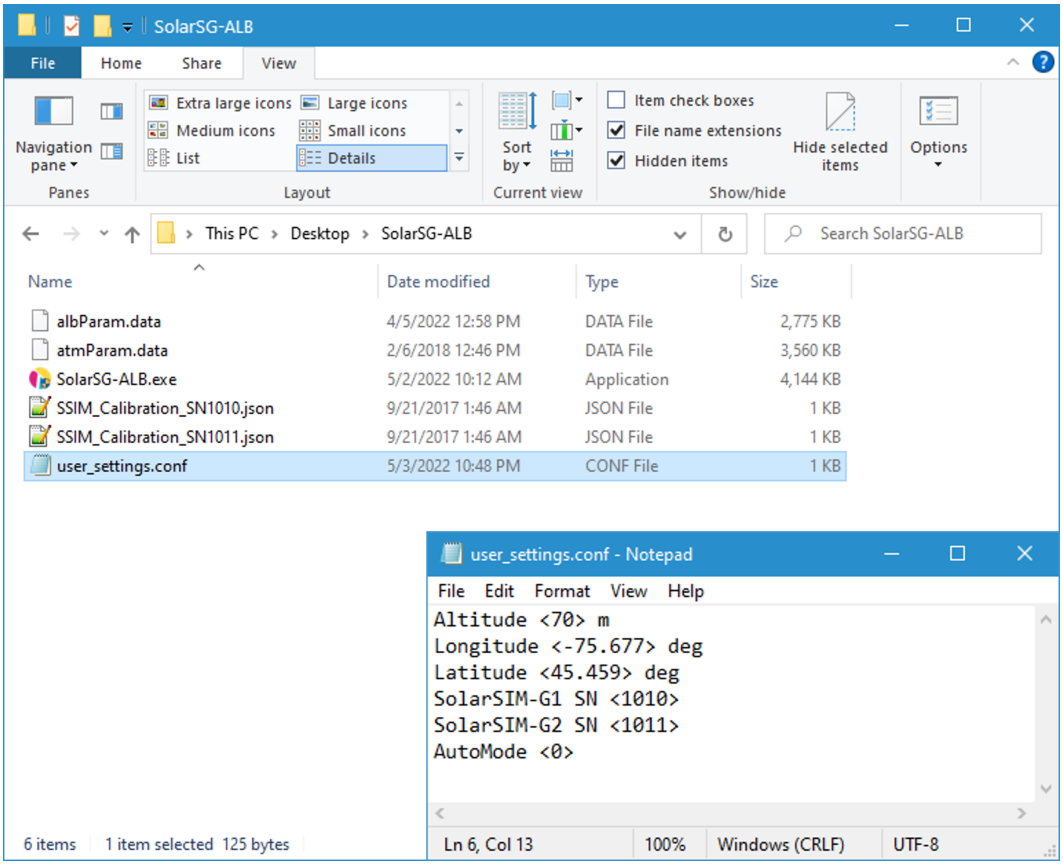

Figure 20: List of files in the SolarSG-ALB directory. The user must configure the settings file before running the application.